

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

PLASTIC RECYCLER

This invention relates to a method and machine for the recycling of plastic waste materials.

BACKGROUND OF THE INVENTION

- 5 Items manufactured from plastic materials are very widely used throughout the world and the tendency appears to be that many forms of plastics material will be more extensively used in the future. However it is well known that many plastic materials are not bio-degradable and that great problems exist in the disposal of such materials. Often hollow plastic articles are themselves
10 deposited in disposal areas, and this assists in producing the large volume of waste which is quickly filling the available disposal areas.

- Various attempts have been made in an attempt to overcome the problem, ranging from simply crushing the articles to occupy less volume in the land fill or disposal area, to attempts to recycle the plastic for further use. However as
15 far as is known, in the recycling of plastic material, the plastic material has to be manually sorted into the various types of plastic, often broadly into thermoplastic material and thermosetting material. However it is often necessary to sort these materials into more specific groups. The thermoplastic materials can be reheated and remoulded into suitable shapes or articles,
20 while the thermosetting materials are usually shredded or granulated for further processing which entails the addition of a suitable binder to bind the particles together in either an extruder or mould.

- Thus the materials have to be manually sorted, and while most plastic articles have a code number printed or embossed thereon, this has first to be located
25 and the material sorted by this number. Error can occur and such errors can be disastrous resulting in the blockage or failure of the processing machine and the consequent complete dismantling of the processing machine so that the offending material can be removed, often by manually chipping away the material. Also in known recycling methods it is often necessary for any labels
30 be first removed, and this task is placed on the person discarding the article, such as the householder.

DESCRIPTION OF THE PRIOR ART

One known apparatus for the recycling of thermoplastic material is shown in US 4,222,748 which comprises a vertical cylindrical container adapted to be charged with thermoplastic material from the top. At the bottom of the container is a rotatable member with a plurality of knives to rotate about the axis of the container. The material is discharged through an opening in the wall of the container into a screw extruder. The material is disintegrated and blended and softened before being fed into the plasticising screw extruder. However as disclosed this apparatus is limited in use to thermoplastic materials.

BRIEF DESCRIPTION OF THE INVENTION

It is an object of this invention to overcome one or more of the above disadvantages of the known prior art, and to provide a method and apparatus where it is not necessary to manually sort the plastic material into different types.

A further object of the invention is to provide a machine for recycling plastic material which will accept a mixture of plastic materials, including thermoplastic and thermosetting materials without the necessity of pre-sorting the material.

Thus there is provided according to one form of the invention a process for recycling plastic materials including the steps of shredding and/or pulverising a mixture of plastic materials containing such that at least some of the plastic material is at least softened whereby on admixture the softened material binds the remaining shredded and/or pulverised material together.

In a further form of the invention there is provided a process of recycling a mixture of plastics materials, said method including the steps of feeding a mixture of plastic material into a pulveriser mixing machine having a plurality of shredding mixing blades rotatable about a vertical axis in a cylindrical casing, an opening in the wall of the casing at about the level of the rotatable blades, said opening leading to an auger in a tube positioned tangentially to the casing, the method including the steps of shredding and pulverising the material by rotating the blades at a rotational speed sufficient to shred and

pulverise the material, the plastics material being heated by friction whereby when heated to a plastic condition is expelled through the opening into the auger.

5 Preferably the auger is an extruder, and the method includes the steps of regulating the temperature of the extruding material by heaters positioned on and in relation to the extruder.

Preferably also the temperature of the material in the pulverising mixing machine is regulated by controlling the rate of addition of plastics material into the cylindrical casing.

10 BRIEF DESCRIPTION OF THE DRAWINGS

In order to more fully describe the invention reference will now be made to the accompanying drawings in which:-

FIG 1 is a side view of one form of the invention;

FIG 2 is a plan view showing the arrangement of the auger; and

15 FIG 3 is a plan view partly in section of the shredder and auger.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In a preferred form of the invention the apparatus 1 comprises a vertical cylindrical casing 2 detachably attached to a horizontal base 3. Immediately above the base 3 there is positioned a plurality of blades 4 on a rotatable disc 5 connected to a drive shaft 6 extending through the base 3, the drive shaft being driven by an electric motor 7. In alternate form the rotatable disc may be dispensed with, the blades being connected directly to the shaft 6. The blades may be of any desired shape but as shown are generally radial and being curved in the direction of rotation to thus provide a shredding, pulverising, 20 mixing action of the material fed into the casing.

The casing 2 is open at the top to permit the mixture of plastic material to be charged into the casing. In order to ensure that the material during operation is not ejected out of the top of the casing, and to ensure that the material is fed

directly onto the blades without bridging in the casing, there is provided a central charging chute 8 extending from the top of the casing downwards to terminate above the rotating blades. The annular area at the top of the casing between the charging chute and the casing is closed by an annular cover 9
5 attached to the charging chute 8. The cover 9 and charging chute 8 can be lifted and removed from the casing for maintenance and cleaning purposes if and when required.

In this way the material is charged into the centre area of the blades, and when thrown out centrifugally, even it is thrown up by the blades, this will be
10 away from the centre of the blades into the annular space between the casing and the charging chute.

An opening 10 is provided in the wall of the casing for the discharge of the plastic material after processing. The opening is positioned in the side of the casing at about the level of the blades, the opening leading to an auger or
15 extruder screw 11 positioned tangentially to the casing. The extruder screw 11 operates in a tube 12, the screw being driven by an electric motor through a reduction gearing. This may be via a reduction gear box, or by a belt drive. Preferably there are means to vary the speed of the screw, and preferably this is via a variable speed electric motor, although a variable speed reduction
20 gear box can be used.

The end of the extruder tube 12 has attached thereto a diverter valve 13 so that the processed material can be selectively directed to either of two outlets. The outlets may be connected to a mould and in one example the outlets are connected in turn to a tubular mould so that the processed material produces
25 cylindrical, square or rectangular posts, rods or rails. In other examples the material is collected in moulds and by pressure various shaped objects can be formed, bricks, rings, discs and the like.

To control the temperature of the plastics material during the extrusion, in order to maintain the extruded temperature, heating elements 14 can be
30 positioned along the extruder tube and the outlets from the diverter valve. These heaters can be thermostatically controlled so that they only operate as desired. The material is preferably fed into the loading chute via a belt conveyor 15, the material preferably being shredded, chopped or divided into smaller pieces before loading onto the conveyor.

The temperature at which the material is extruded can be in the range of 100°C to 200°C, the preferred temperature being in the order of 140°C. If the temperature is too high the processed material can be too fluid, and also the temperature must be below the temperature at which plastic materials can decompose and give off noxious gases. In order to assist in controlling the temperature, a fan 16 has its outlet connected to the bottom of the casing above the opening to the screw conveyor. Thus the fan preferably is temperature controlled so that it only becomes operative when the temperature of the processed material exceeds an upper limit in the order of 160°C.

It is preferred that the extruder screw be between 500 to 1500mm, the ideal length being 1000mm. The screw is to be of a length such that the material is suitably compressed, but if the length exceeds 1500mm the power and torque required can be excessive resulting in power losses and possible damage to the extruder screw and drive.

In operation the belt conveyor is operated to charge a quantity of material into the casing. The belt conveyor is then stopped, the heaters on the tube and diverter valve be turned on and the motor driving the blades in the casing be activated. The screw extruder is not driven at this stage. The degree of processing of the materials in the casing is monitored. This is achieved by noting the load on the blades on the disc as indicated by the current drawn by the driving motor. As the material is processed, the softened material begins mixing with the finely comminuted material and the material becomes more viscous thus creating a load on the blades and motor. This increase on the load is indicated by the current flow to the motor and when this reaches a desired level, the extruding screw is driven. The feeding conveyor can also be controlled by the load on the blades, so that it is actuated to add more material when the load is high. Thus the rate of feeding of the material is determined by the condition of the material being processed in the casing.

It is preferred that the casing diameter be in the range of 300mm to 2000mm and the rotor and blades are driven in a speed range of 900 to 2400 RPM, preferably 1480 RPM whereby the material is shredded and pulverised, and during this operation the frictional forces of the shredding and pulverising of the material inside the casing develops heat sufficient to soften the thermoplastic material to the extent that it binds the finely comminuted other

plastic materials into a soft mouldable and workable mass. It appears that the thermoplastic material shrinks or contracts and becomes soft and so is in a condition to bind the other finely commuted material into a coherent mass.

5 The speed of the rotor and blades can be varied if desired, and also preferably the speed of the screw conveyor extruder screw is variable to be adjusted to the rate of processing of the material in the casing.

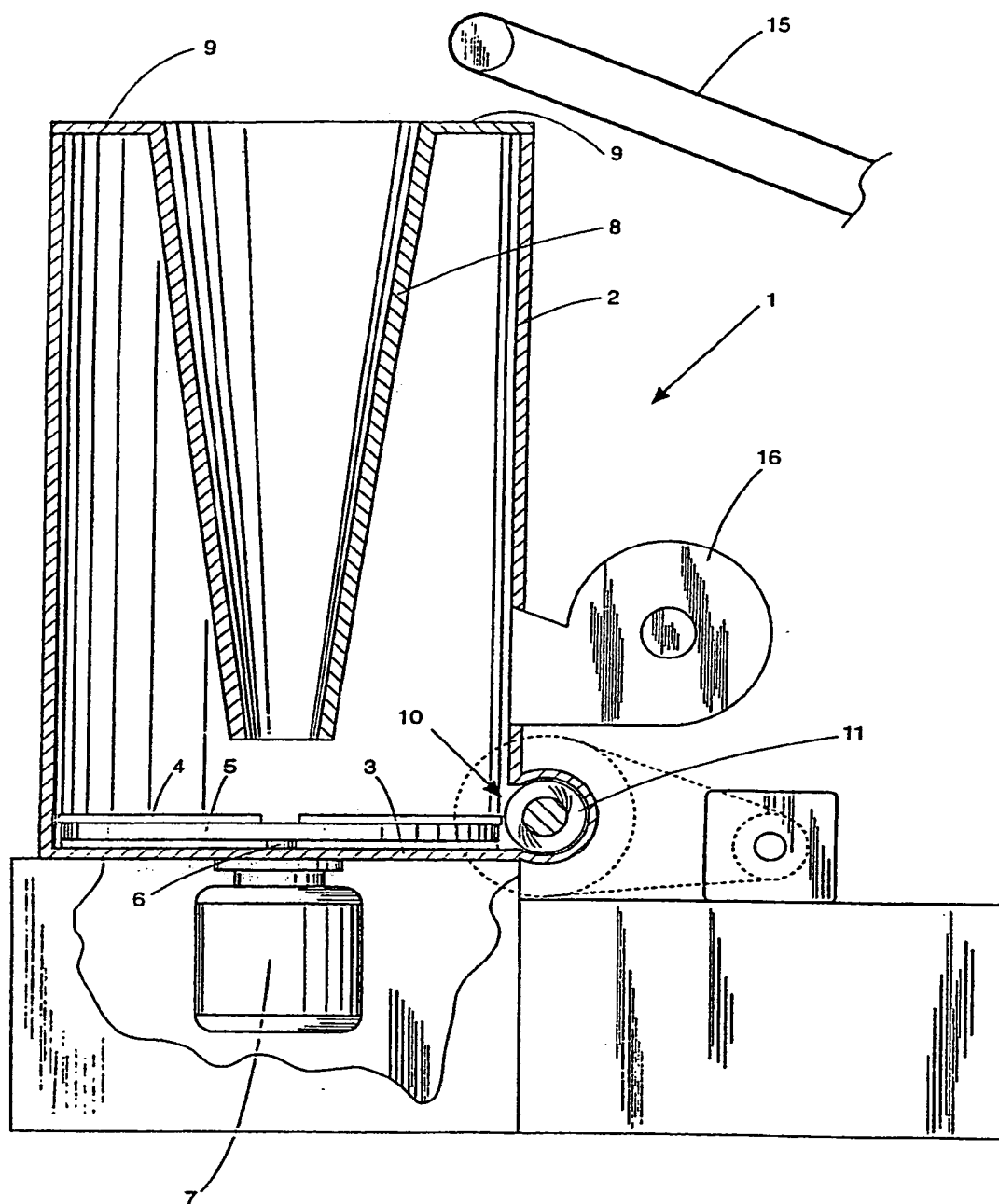
10 The product which emerges from the extruder screw has a consistency of putty or workable clay, and so can be moulded, pressed or otherwise formed into any desired shape. On cooling the product is solid, hard, has strength against breakage. As an example it is suitable for the manufacture of fence posts, building bricks, and so is suitable for the manufacture of a large range of products.

15 Although one form of the invention has been described in some detail it is to be realised that the invention is not to be limited thereto, but can include variations falling within the spirit and scope of the invention.

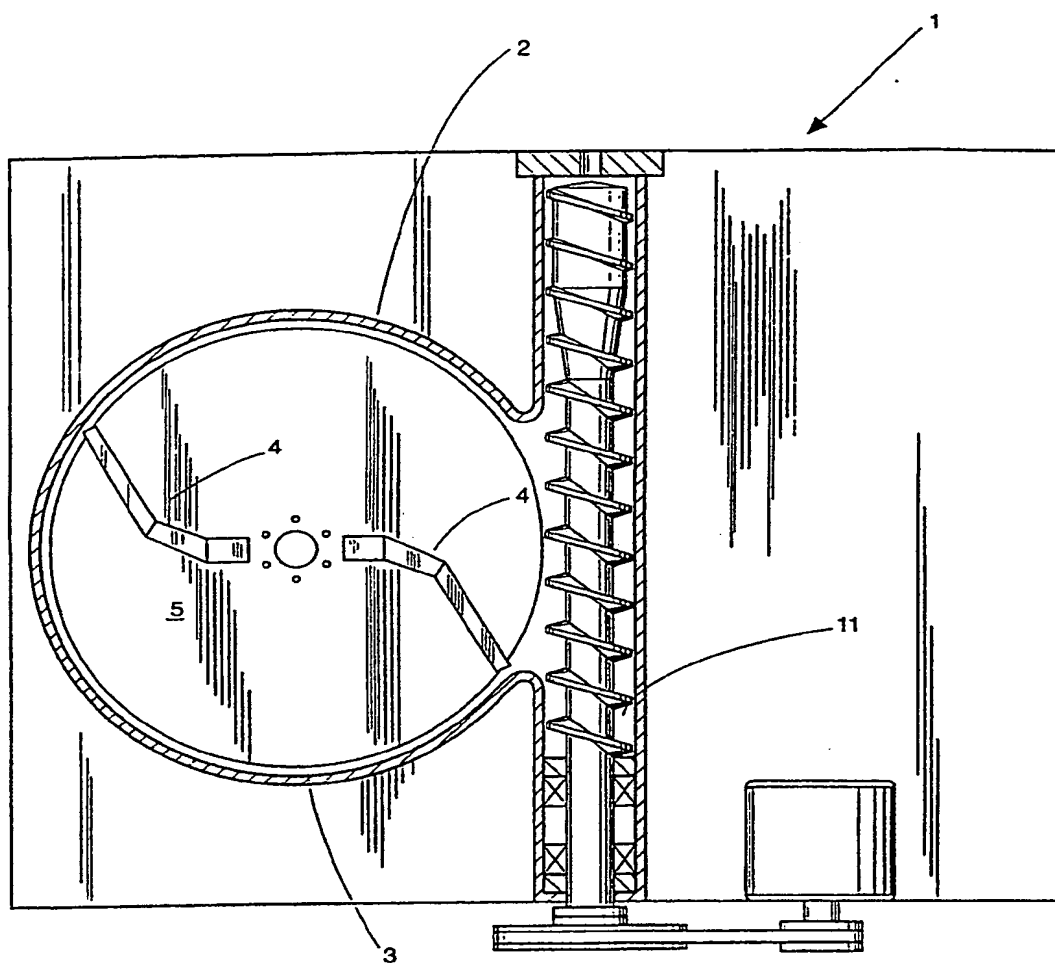
CLAIMS:

1. A process for recycling plastic materials including the steps of shredding and/or pulverising a mixture of plastic materials containing such that at least some of the plastic material is at least softened whereby on admixture the softened material binds the remaining shredded and/or pulverised material together.
2. A method of recycling a mixture of plastics materials, said method including the steps of feeding a mixture of plastic material into a pulveriser mixing machine having a plurality of shredding mixing blades rotatable about a vertical axis in a cylindrical casing, an opening in the wall of the casing at about the level of the rotatable blades, said opening leading to an auger in a tube positioned tangentially to the casing, the method including the steps of shredding and pulverising the material by rotating the blades at a rotational speed sufficient to shred and pulverise the material, the plastics material being heated by friction whereby when heated to a plastic condition is expelled through the opening into the auger.
3. A method of recycling a mixture of plastics materials, said method including the steps of feeding a mixture of plastic material into a pulveriser mixing machine having a plurality of shredding mixing blades rotatable about a vertical axis in a cylindrical casing, an opening in the wall of the casing at about the level of the rotatable blades, said opening leading to an extruding auger in a tube positioned tangentially to the casing, the method including the steps of shredding and pulverising the material by rotating the blades at a rotational speed sufficient to shred and pulverise the material and for a sufficient time to develop heat whereby portions of the plastics materials are softened sufficiently to bind the comminuted and pulverised material into a plastic mass and fed through the opening into the extruding auger.
4. A method of recycling plastics materials as defined in claim 3, including the step of regulating the temperature of the extruding material by heaters positioned on and in relation to the extruder.
5. A method of recycling plastics material as defined in claim 3 including the step of chopping or shredding material to be recycled and feeding the material into the casing by means of a conveyor.

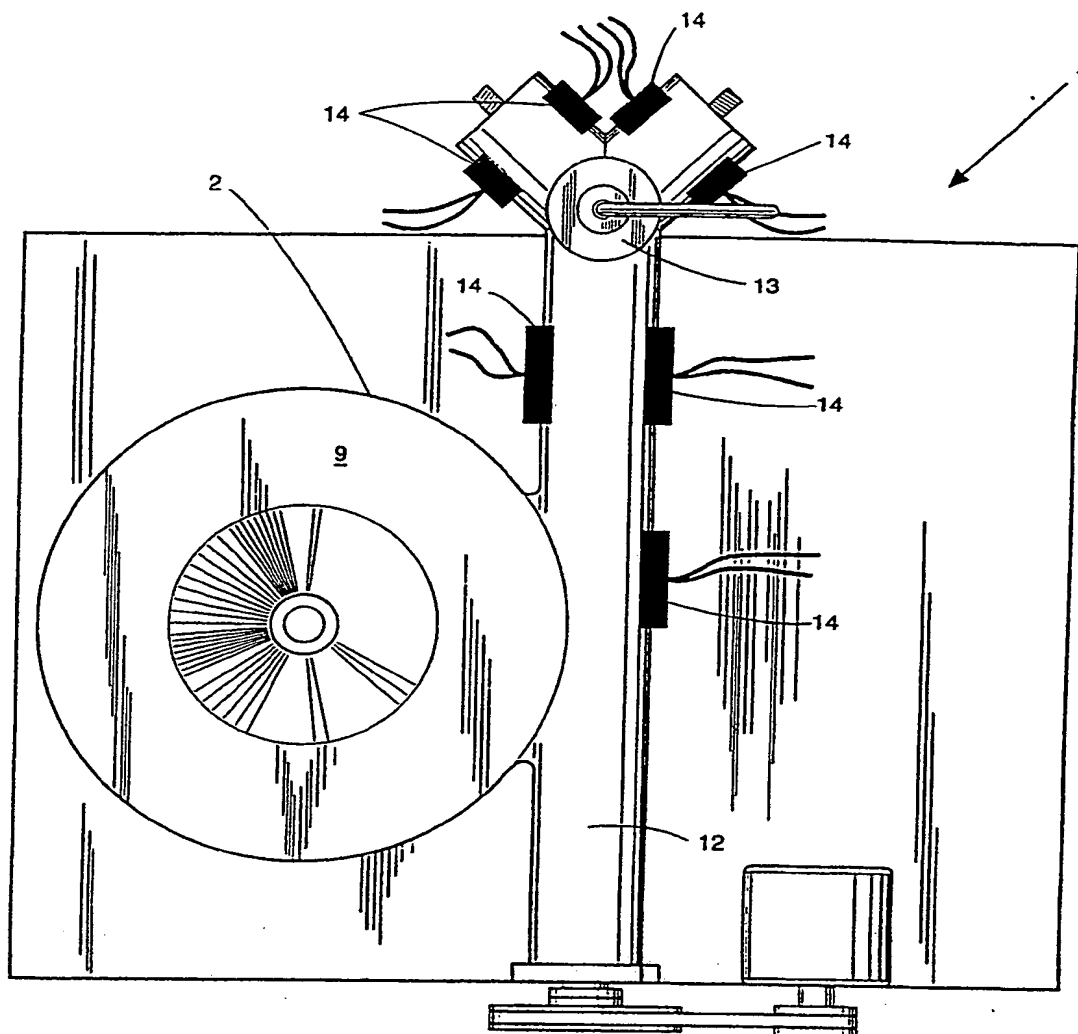
6. A method as defined in claim 5 wherein the processing of the material in the cylindrical casing is regulated by controlling the rate of addition of plastics material into the cylindrical casing.
 7. A method as defined in claim 3 including the step of controlling the temperature within the cylindrical casing by blowing air into the casing over the material being processed.
- 5



2/3

**FIGURE 2**

3/3

**FIGURE 3**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 95/00342

A. CLASSIFICATION OF SUBJECT MATTERInt. Cl.⁶ B29B 17/00, B02C 18/44 //B29B 7/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC B29B 17/00, B29C 29/00, B02C 18/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as aboveElectronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DERWENT: (SOFT: OR HEAT: OR MELT:) AND (SHRED: OR PULV: OR CUT: OR SLIC:) and IPC as above
JAPIO: (SOFT: OR HEAT: OR MELT:) AND (SHRED: OR PULV: OR CUT: OR SLIC:) AND IPC as above**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US 4222728 A (BACHER et al.) 16 September 1980 whole document	1-7
X	GB 1190395 A (FELLNER & ZIEGLER GMBH) 6 May 1970 whole document	1
X	WO 92/18312 A (MARIANI CINZIA LICIA D.I.) 29 October 1992 whole document	1
X	EP 0578603 A (WUORELA) 12 January 1994 whole document	1

☐ Further documents are listed
in the continuation of Box C.☒ See patent family annex.*** Special categories of cited documents :**

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
4 August 1995

Date of mailing of the international search report

23 AUGUST 1995

Name and mailing address of the ISA/AU

AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION
PO BOX 200
WODEN ACT 2606
AUSTRALIA

Facsimile No. 06 2853929

Authorized officer

S. J. YONG

Telephone No. (06) 2832160

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 95/00342

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US,A 4222728	AT,B, 354076 GB,B2, 2024043 NL,B, 187000	BR,A, 7901126 IT,A, 1111137	FR,B1, 2418707 JP,A2, 54124062		
GB,A, 1190395	DE,A, 1679834 US,A, 3685748	SE,B, 315387	US,A, 3510067		
WO,A, 92/18312	AU,B, 653011 CA,A, 2085236 DK,A, 1504/92 GB,A, 2260329 IL,A, 101563 LU,A, 88199 NZ,A, 242352 ZA,A, 9202833	BE,A, 1005779 CN,A, 1067602 EP,A, 539534 GR,B, 1001132 IT,A, 91840288 NL,A, 9220001 OA,A, 9799	BR,A, 9205235 CN,A, 1067844 FI,A, 925446 HU,A2, 66956 JP,T2, 5508122 NO,A, 924633 PT,A, 100385		
EP,A, 578603	DK,A, 766/92	FI,A, 932686	NO,A, 932124		
END OF ANNEX					

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☒ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.